

Global Water Resources and Public Policy

**by Nadine L. Romero
Ground Water Science Services,
LLC**

World Water Heritage

“Do We Really Respect our Water?”

----John Vaccaro, USGS

April 8, 2003

**What I want to pose
today:**

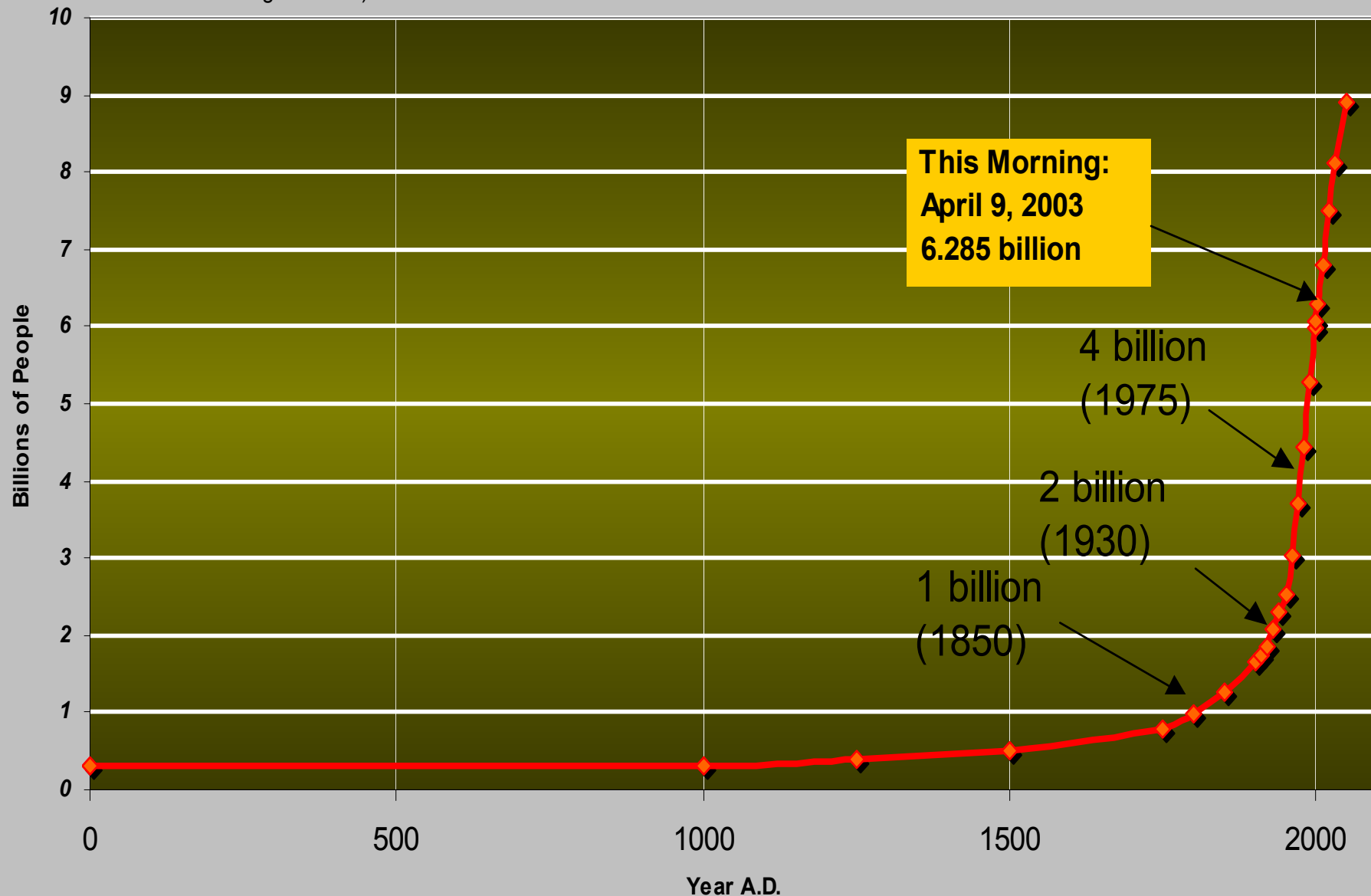
*Are we entering a Malthusian
'cul de sac'?*

“How do we balance human needs
with the requirements of natural
systems?”

---National Geographic, “Earth’s Fresh Water Under
Pressure, September Issue, 2002

(United Nations Statistics Database,
Graphed by N. Romero for
Page Carter, Sr. 1/25/03;
Modified after Tarbuck/Lutgens 2002)

World Population (Billions)



Millenium Development Goals (MDG's) from the Johannesburg Earth Summit 2002:

By 2015, reduce by half the proportion of people without sustainable access to safe drinking water and without access to basic sanitation.

3rd World Water Forum, Kyoto Japan, March 2003:

- 422 Actions submitted
- Water Resource Security
- Deal with Water Scarcity
- Financial flows need to 2X



Hydromythology and Ethnohydrology in the New World

WILLIAM BACK

U.S. Geological Survey, Reston, Virginia 22092

From mythology, archeology, and chronicles of early explorers we can learn how early Americans viewed the cause and effect relations of hydrologic phenomena. Hopes and fears are the basis of religion, and it was through religion that water management was first practiced. Early people used their water resources to develop diverse civilizations in various parts of the western hemisphere. Not only was the rise of these earlier civilizations hydrologically influenced, but also the downfall of some was related to natural or man-made hydrological crises in which gods and mythology continued to play a role.

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THE HIGH DAM AT ASWAN, EGYPT

BOB BURCH, BRUCE COLEMAN

THE NATURAL WORLD

The Politics of Running Out of Water

By Malcolm G. Scully

PRESIDENT of the World Bank predicted in 1995 that wars of the next century will be over water."

The forecast of Ismail Serageldin, director of the World Commission on Water for the 21st Century, is that, and few observers expect to break out at any moment in the spate of popular and academic books and articles suggesting that we are facing a "water crisis" that is a threat to social, economic, and environmental stability.

In the article titled "Running Dry" in *Time* (July 2000), Jacques

The authors of several recent books predict that, whether or not water wars loom, tension and contention over its acquisition and allocation will inevitably increase. And, they suggest, devising and sustaining a system in which the economic, social, environmental, and equity issues are resolved without open conflict will require tough choices and far more ingenuity and collaboration than have historically been applied to questions of access to and distribution of water.

As Peter H. Gleick, president of the Pacific Institute for Studies in Development, Environment, and Security, writes in *The World's Water: 2000-2001*, "The

scarcity is taking shape that threatens the security of nations and the stability of civil societies."

"Tensions over water security," she adds, "have the potential to incite civil unrest, spur migration, impoverish already poor regions, and destabilize governments—as well as to ignite armed conflict."

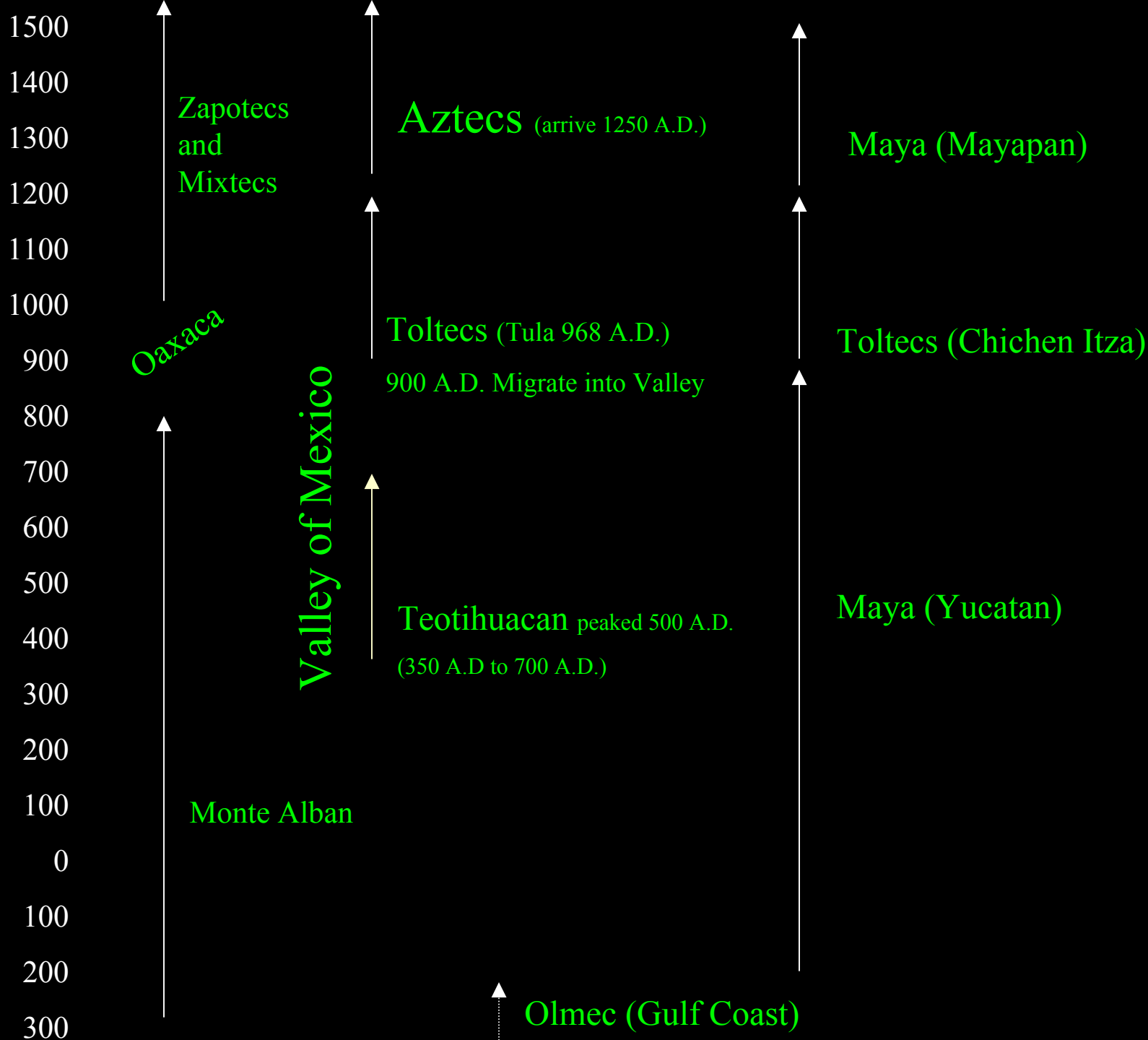
Thomas F. Homer-Dixon, a political scientist and director of the peace and conflict-studies program at the University of Toronto, cautions—in *Environment, Scarcity, and Violence*—that "sensational claims about 'water wars,' 'food wars,' and 'environmental refugees' in the popular

"a major factor behind these wars we can expect it to become a powerful influence in coming decades of larger populations and higher per capita resource consumption rates."

Both Homer-Dixon and Lester R. Brown, former vice president of the World Bank who now directs the World Policy Project, in Amherst, Mass., cite a series of cases in which water scarcity could lead to conflict.

Homer-Dixon suggests, for example, that Israeli policies on allocating water to the West Bank may have been a factor in the violence there. Brown, in the West Bank account







Principal God of the Aztec Empire

Chalchiuhtlicue

“Lady of Water”

- Make cultural connection to science
- Show Mexican cultural history through the lens of hydrology -- role of hydrology in shaping a civilization
- Hydrologic science contributions of Aztecs poorly understood:

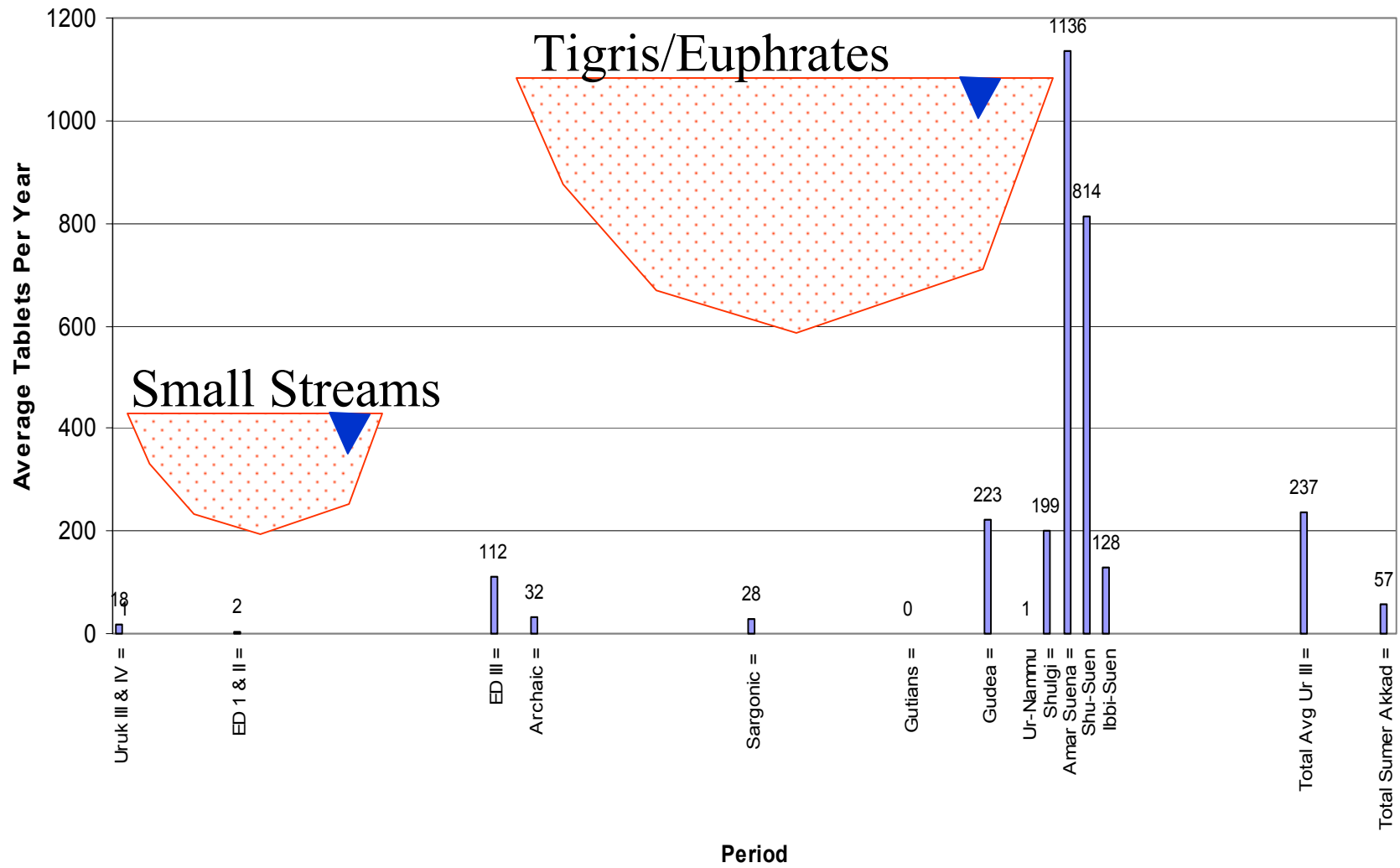
Tenochtitlan represented a gigantic hydraulic scheme based on land drainage and *masterful manipulation* of water resources

- Sustainability: We have yet to achieve anything like it today.





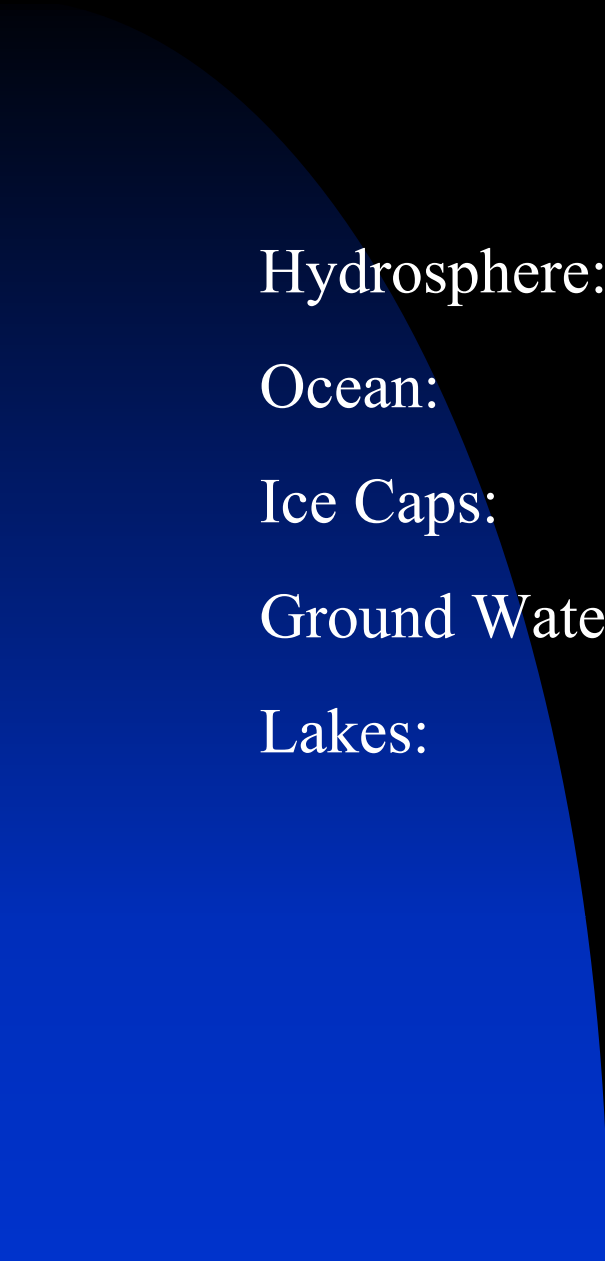
Estimated Annual Rates of Tablet Production











Hydrosphere:	325 Million Cubic Miles	100%
Ocean:	316 Million Cubic Miles	97.2%
Ice Caps:	7 Million Cubic Miles	2.15%
Ground Water:	2 Million Cubic Miles	0.618%
Lakes:	30 Thousand Cubic Miles	0.0088%

Source: Feth, 1972 (Conversions: N. Romero)

Quantities of Water in the Hydrosphere	Cubic Kilometers (km ³)	Cubic Miles (mi ³)	Percentages			
Total Amount of Water In The Hydrosphere	1,358,000,000.00	325,801,833	100%			
Water Stored in Oceans	1,320,000,000.00	316,685,140		97.20%		
Water Stored in/on Land	38,000,000.00	9,116,693		2.88%		
Cryosphere (Ice Caps & Glaciers)	29,200,000.00	7,005,459			2.15%	
Other Water (Ground Water; Soil Moisture; Lakes; Rivers)	8,800,000.00	2,111,234			0.65%	
Ground Water	8,400,000.00	2,015,269				0.6186%
Lakes	120,000.00	28,790				0.0088%
Atmosphere	14,000.00	3,359				0.0010%
Soil Moisture	70,000.00	16,794				0.0052%
Saline Lakes	110,000.00	26,390				0.0081%
Rivers	1,400.00	336				0.0001%

Various Water Facts	km ³	mi ³	gallons	acre-ft	acres	Citations
US Ground Water Withdrawals (Yearly)-1993	468.00	112.28				(1)
Daily Evaporation on Globe	1,041.00	249.75				(1)
Florida Aquifers (US) Yield (Yearly)	6.22	1.49				
Florida Aquifers (US) Withdrawal w/o Sea H2O Intrusion (Yearly)	0.22	0.05				
Actual Withdrawal (Yearly)	0.44	0.11				
Central Valley Aquifer (CA) Accessible Yield	308.00	73.89		2.50E+08		
CA Average Precipitation (24"/yr)	238.00	57.10		1.93E+08		
Ogallala Aquifer Head Loss (Avg 50')	690.00	165.54				
Ogallala Aquifer Head Loss (Avg 100')	1,479.00	354.83				
La Mancha Aquifer (Spain) Withdrawal Yearly	60,000.00	14,394.78				(3)
Overpumpage of La Mancha Aquifer	20,000.00	4,798.26				
McAllister Springs - Olympia - Yield (Yearly)	0.0239	0.0057	6.00E+09	1.84E+04		
(Flow: 12,000 gpm)	0.0239	0.0057	6.31E+09	1.93E+04		
All Discharging Springs - Olympia - Yield (Yearly)						
dwards Aquifer (TX) Yields (Withdraw = Rch) Yearly	0.7893	0.1894		6.40E+05		(1)

Loss Estimates	km ³	mi ³	mi ²	acre-ft	acres	Citations
Aquifers						
CA Aquifer Framework Collapse	24.6600	5.9163		2.00E+07		(1)
Ogallala Aquifer Head Loss (Avg 100')	1,479.00	354.83				
Wetlands						
Las Tablas (Spain) Castile-La Mancha (1900)					60,000	(2)
(2002)					14,000	
Donana Wetlands (Spain) - (1900)					370,000	
(2002)					75,000	
Sub Total (Spain) Loss of Wetlands *Est	4.1900	1.0052			341,000	
Tule Lake (CA)					100,000	(2)
(2002)					10,000	
Sub Total (CA) Loss of Tule Wetlands	2.2100	0.5302			90,000	
Marshes of Iraq - Largest Wetland in Middle East	60.9000	14.6107	7,725			(7)
(2002)	9.4719	2.2724	1,159			
Sub Total (Iraq) Loss of Wetlands	51.4281	12.3383	6,566.25			
Great Lakes Freshwater System			94,000			(2)
41" Head Loss in Great Lakes (2002)						





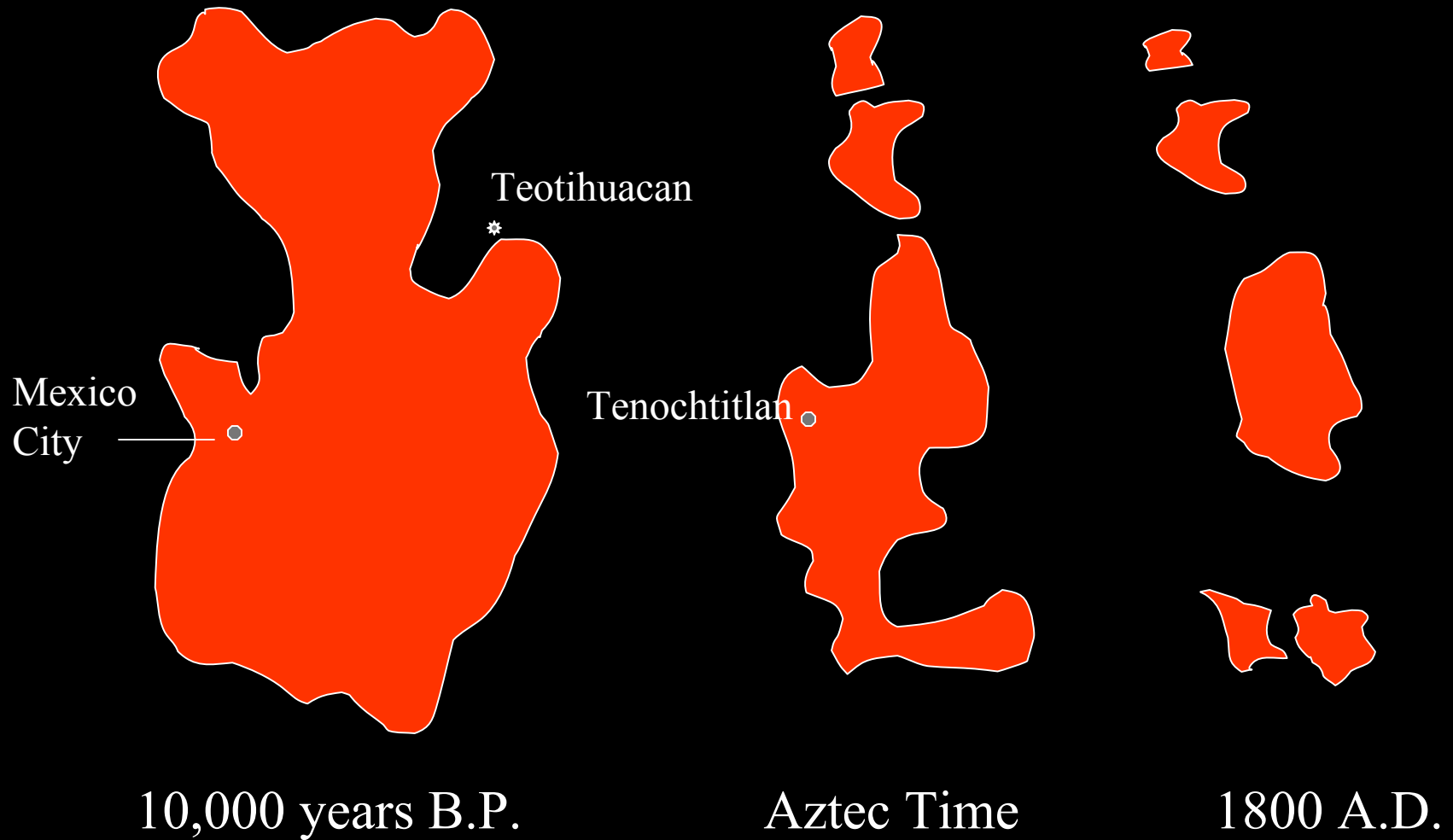








Change In Size of Lake in Valley of Mexico



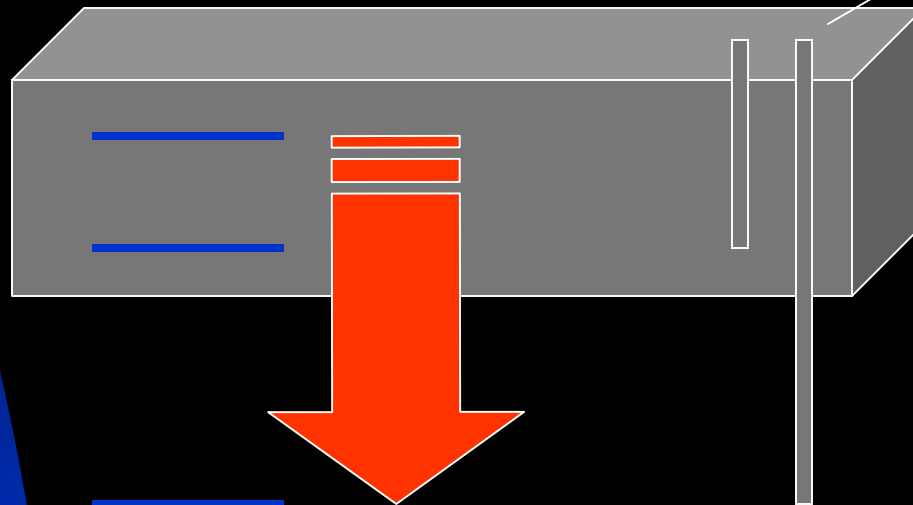
Adapted from Back, 1981

Mexico City Subsidence

1957 - 3000 Wells

13 feet

100 feet





Water Technologic Innovation and Water Economics

Population Growth Rate Exceeds Our Water Usage Rate

$$P = P_0 e^{0.013t}$$

$$W = W_0 e^{0.06t}$$

Technologic Change

- Learning
- Invention
- Innovation

Entrepreneurship drives economies

Allocation of resources for invention? (Arrow, 1962)

What is going on in the market? Firm behavior?

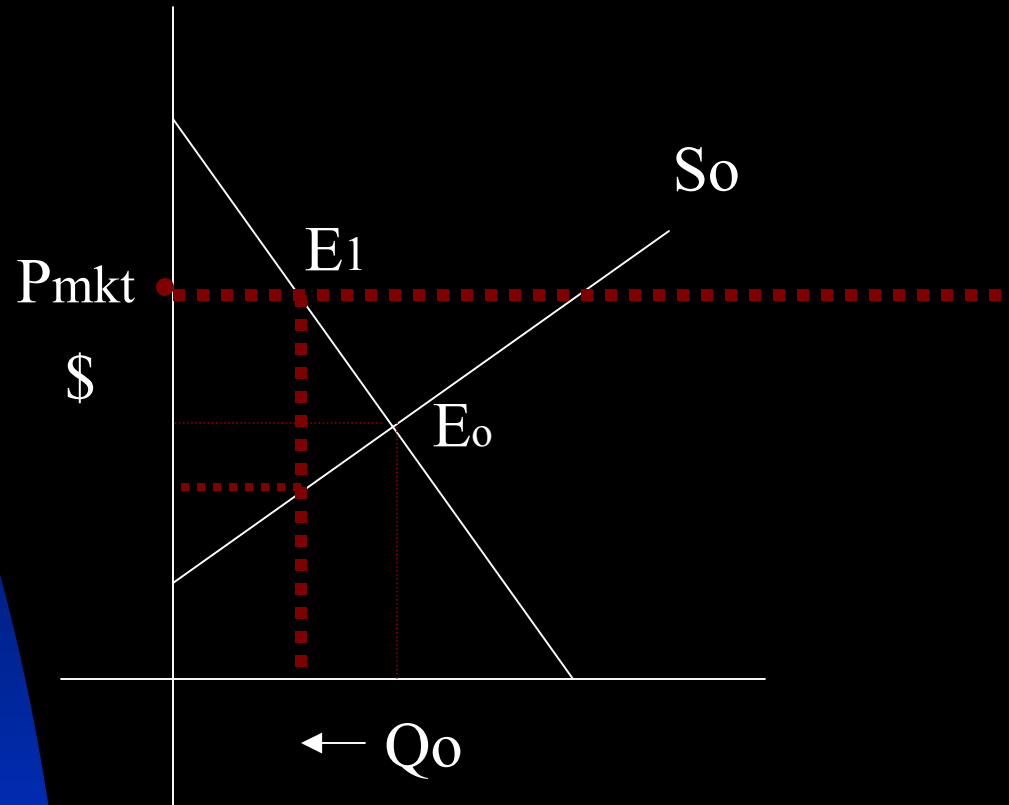
Many different types of Market Failure:

- People aren't always “price takers”
- Monopolies (dynamic views on R&D)
- Other Dynamics Involved

Should government finance research & invention?

Drive Technologic Innovation

Sustainable Economics



Apply? Groundwater Depletion Tax

Valuation of Water

Incentives Cost Recovering Tariffs

Regulation

Public Policy

New Varieties of Food

Water Conservation

Technologic Innovation

Eliminate Information Asymmetry

Visibility (Types of knowledge not at the table)

Public Learning Tools

Financial Mechanisms

Innovation in Governance

Transparency

Communities of Practice

Human Capability & Biogeophysical Imagination

Leadership

- Widening the leadership path
- Bennet (1996) and Gardner (1995):

“The globe faces three extraordinary threats including the threat of ‘annihilation’ of worldwide plague or ecological catastrophe and a deepening leadership crisis in most of the world’s institutions.”

- Being better ‘narrators’ about the water story and understanding our roles as ‘purveyors’ of water knowledge.
- Being big enough to place science in the hands of the public & enhancing human capability and understanding.



Think Like an Aztec